cipitation was 3.40, or 0.51 below normal; the greatest monthly amount, 9.97, occurred at McCune Station, and the least, 0.60, at Emma.—*A. E. Hackett.*

Montana.—The mean temperature was 64.0°, or 4.0° below normal; the highest was 103°, at Fort Keogh on the 27th, and the lowest, 32°, at Castle on the 9th and at Kipp on the 18th. The average precipitation was 1.64, or 0.17 below normal; the greatest monthly amount, 3.24, occurred at Great Falls, and the least, 0.19, at Fort Keogh.—*R. M. Crawford.*

Nebraska.—The mean temperature was 75.9°, or 0.6° above normal; the highest was 112°, at Franklin on the 23d, and the lowest, 34°, at Camp Clark on the 10th. The average precipitation was 2.57, or 0.92 below normal; the greatest monthly amount, 7.44, occurred at Chester, and the least, 0.35, at Whitman.—*G. A. Loveland.*

Nevada.—The mean temperature was 69.4°, or 3.0° below normal; the highest was 116°, at St. Thomas on the 11th, 12th, and 27th; the lowest was 25°, at Hamilton on the 2d. The average precipitation was 0.27, or 0.01 above normal; the greatest monthly amount, 1.41, occurred at Palmetto, while no rain fell at several stations.—*R. F. Young.*

New England.—The mean temperature was 70.6°, or 1.1° above normal; the highest was 102°, at Plymouth, N. H., on the 5th, and the lowest, 40°, at Bar Harbor, Me., on the 19th, at West Milan, N. H., on the 27th, and at Flagstaff, Me., on the 28th. The history of the regular and voluntary observation service in New England furnishes no parallel to the precipitation record of this July. The extremes in the total falls of the month were 2.62 inches at Portland, Me., and 19.90 inches at Southington, Conn., a most remarkable variance considering the comparatively small area of this district.—*J. W. Smith.*

New Jersey.—The mean temperature was 74.1°, or 0.5° below normal; the highest was 100°, at Boonton, Dover, and Riverdale on the 10th, and the lowest, 50°, at Charlotteburg on the 16th. The average precipitation was 11.42, or 7.14 above normal; the greatest monthly amount, 20 80, occurred at Elizabeth, and the least, 6.11, at Camden.—*E. W. McGann.*

New Mexico.—The mean temperature was about 2.5° below normal; the highest was 104°, at Eddy on the 14th, and the lowest, 24°, at Winsors Ranch on the 20th. The greatest monthly precipitation, 5.60, occurred at Lower Penasco, and the least, 0.10, at Raton.—*H. B. Hersey.*

New York.—The mean temperature was 72.5°, or 2.5° above normal; the highest was 102°, at Avon on the 5th and 10th, and the lowest, 43°, at South Kortright on the 9th. The average precipitation was 6.69, or 3.02 above normal; the greatest monthly amount, 18.18, occurred at Setauket, and the least, 2.20, at Mount Morris.—*R. M. Hardinge.*

North Carolina.—The mean temperature was 77.2°, or 0.4° below normal; the highest was 103°, at Saxon on the 3d, and the lowest, 45°, at Highlands and Linville on the 15th. The average precipitation was 5.60, or normal; the greatest monthly amount, 11.11, occurred at Fayetteville, and the least, 2.07, at Sloan.—*C. F. von Herrmann.*

North Dakota.—The mean temperature was 68.9°, or 0.2° above normal; the highest was 109°, at Medora on the 28th, and the lowest, 38°, at Bordulac on the 4th. The average precipitation was 4.43, or 2.06 above normal; the greatest monthly amount, 8.94, occurred at Amenia, and the least, 0.33, at Glen Ullin.—*B. H. Bronson.*

Ohio.—The mean temperature was 75.5°, or 2.4° above normal; the highest was 113°, at Thurman on the 4th, and the lowest, 44°, at Levering on the 14th and 15th. The average precipitation was 4.65, or 1.09 above normal; the greatest monthly amount, 10.69, occurred at Ashtabula, and the least, 0.82, at Hedges.—*H. W. Richardson.*

Oklahoma.—The mean temperature was 82.4°; the highest was 110°, at Kingfisher and Winnview on the 14th, and the lowest, 48°, at Burnett on the 13th. The average precipitation was 2.05; the greatest monthly amount, 5.12, occurred at Beaver, and the least, 0.48, at Woodward.—*J. I. Widmeyer.*

Oregon.—The mean temperature was 63.7°, or 0.9° below normal; the highest was 107°, at Pendleton on the 11th, and the lowest, 28°, at Silver Lake on the 17th. The average precipitation was 0.58, or 0.12 above normal; the greatest monthly amount, 3.69, occurred at Bay City, while no rain fell at several stations.—*B. S. Pague.*

Pennsylvania.—The mean temperature was 73.4°, or 2.4° above normal; the highest was 103°, at Aqueduct on the 6th, and at Derry Station on the 5th and 6th, and the lowest, 41°, at Lock Haven on the 29th. The average precipitation was 6.26, or 2.11 above normal; the greatest monthly amounts were 14.51 at Saegerstown, 13.10 at Swiftwater, 12.42 at Forks of Neshaminy, 11.45 at Shawmont, 10.94 at Elwood Junction, and 10.25 at Philadelphia, Centennial Avenue; the least, 2.10, occurred at Cannonsburg.—*T. F. Townsend.*

South Carolina.—The mean temperature was 80.2°, or 0.4° above normal; the highest was 107°, at Batesburg on the 3d, and the lowest, 54° at Walhalla on the 15th. The average precipitation was 5.91, or 0.11 below normal; the greatest monthly amount, 9.81, occurred at St. Stephens, and the least, 2.99, at Spartansburg.—*J. W. Bauer.*

South Dakota.—The mean temperature was 72.8°, or about normal; the highest was 107°, at Ashcroft on the 28th, and the lowest, 35° at Ashcroft on the 20th. The average precipitation was 3.26, or 0.65 above normal; the greatest monthly amount, 7.27, occurred at Castlewood, and the least, 0.46, at Spearfish.—*S. W. Glenn.*

Tennessee.—The mean temperature was 77.7°, or 1.0° above normal; the highest was 105°, at Savannah on the 2d and at St. Joseph on the 2d and 3d, and the lowest, 46° at Erasmus on the 14th. The average precipitation was 5.09, or 0.46 above normal; the greatest monthly amount, 13.21, occurred at Oak Hill, and the least, 0.40, at Brownsville.—*H. C. Bate.*

Texas.—The mean temperature for the State was 1.6° above the normal. There was a general excess throughout the State except over the Panhandle and the mountainous portions of west Texas, where it ranged from the normal to 2.3° below. The greatest deficiency was at El Paso. The excess ranged from 0.2° to 3.5° over east and central Texas and the coast district, and from 1.2° to 3.9° over north and southwest Texas. The highest was 112°, at Waxahachie on the 26th, and the lowest, 48° at Mount Blanco on the 18th. The average precipitation for the State was 1.00 below the normal. There was a general deficiency throughout the State, except in the vicinity of Brenham and over north Texas, the Panhandle, the northern portion of central Texas, and the western portion of west Texas, where there was an excess ranging from 0.01 to 4.75, with the greatest in the vicinity of Gainesville. The deficiency ranged from 0.25 to 3.11 over east Texas, the southern portion of central Texas, and the eastern portion of west Texas, and from 0.54 to 5.21 over southwest Texas and the coast district, with the greatest deficit in the vicinity of Brazoria. Drought prevailed during the greater portion of the month. The rainfall was very poorly distributed over the State, there being comparatively no precipitation in many places, while there were good local showers at several places in north Texas. The greatest monthly amount, 7.32, occurred at Gainesville, while none fell at some stations.—*I. M. Cline.*

Utah.—The mean temperature was 68.7°; the highest was 110°, at St. George on the 11th, and at Mount Pleasant on the 12th, and the lowest, 23°, at Soldier Summit on the 18th. The average precipitation was 0.55; the greatest monthly amount, 1.70, occurred at Pahreah, and the least, 0.02, at Soldier Summit.—*J. H. Smith.*

Virginia.—The mean temperature was 76.4°, or 0.1° above normal; the highest was 100°, at Bon Air on the 3d, and at Woodstock on the 7th, and the lowest, 46°, at Big Stone Gap on the 14th. The average precipitation was 4.46, or 0.85 above normal; the greatest monthly amount, 7.70, occurred at Stanardsville, and the least, 1.70, at Bedford City.—*E. A. Evans.*

Washington.—The mean temperature was 62.4°, or 2.2° below normal; the highest was 107°, at Kennewick on the 11th, and the lowest, 32°, Cascade Tunnel on the 25th. The average precipitation was 1.39, or 0.72 above normal; the greatest monthly amount, 4.00, occurred at Snohomish, and the least, trace, at Fort Simcoe.—*G. N. Salisbury.*

West Virginia.—The mean temperature was 74.2°, or 3.0° above normal; the highest was 102°, at Point Pleasant on the 4th, and the lowest, 46°, at White Sulphur Springs on the 14th. The average precipitation was 5.43, or more than 1.00 above normal; the greatest monthly amount, 9.92, occurred at Beverly, and the least, 2.85, at Martinsburg.—*H. L. Ball.*

Wisconsin.—The mean temperature was 72.5°, or 2.0° below normal; the highest was 102°, at Prairie du Chien on the 8th, and the lowest, 41°, at Medford on the 13th. The average precipitation was 3.83, or 0.74 above normal; the greatest monthly amount, 15.11, occurred at Butternut, and the least, 1.20, at City Point.—*W. M. Wilson.*

Wyoming.—The mean temperature was 65.6°, or 2.0° below normal; the highest was 105°, at Lusk and Wamsutter on the 28th, and the lowest, 28°, at Atlantic City on the 3d. The average precipitation was 1.22, or 0.04 above normal; the greatest monthly amount, 3.77, occurred at Cheyenne, and the least, 0.03, at Wamsutter.—*M. F. Renoe.*

RIVER AND FLOOD SERVICE.

By PARK MORRILL, Forecast Official, in charge of River and Flood Service.

The highest and lowest water, mean stage, and monthly range at 114 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: Keokuk, St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

The following résumé of river stages and conditions of navi-

gation in the respective streams is compiled from reports by the officials of the Weather Bureau at various river stations and section centers:

Hudson River. (Reported by A. F. Sims, Albany, N. Y.)—During the first decade of July normal conditions obtained in the Hudson River and its tributaries. Heavy rains in the second decade sent all the rivers and creeks in this section beyond their natural confines. A heavy current was running in the Hudson River and boatmen experienced much difficulty in making their landings and in handling their craft. The passenger steamers and the towing lines when they tied up their boats on the night of the 14th put out extra hawsers to prevent them from being carried down stream. At 7:40 a. m. of the 15th the river was within 7 inches of the top of the dock at Albany; the highest point reached was 8.6 feet above mean low water. The river receded slowly during the 16th, and was about normal by 8 a. m. of the 18th. During the third decade of July the stage of the river remained slightly above the normal.

Susquehanna River and branches. (Reported by E. R. Demain, Harrisburg, Pa.)—The average rainfall within the drainage area of the river and its tributaries during the past month, as deduced from reports from sixteen river stations, was only 80 per cent of the average amount for July, 1896, and, as might be expected from such a deficiency, lower stages ruled in all the streams than during the corresponding period last year. The general rain which fell in Pennsylvania on the 27th and 28th was followed by the only freshet during the month, and caused rises in the various rivers and creeks, ranging from a fraction of a foot to 6 feet. The lowest waters occurred on the west branch; at Sinnemahoning and Cedar Run the water was below the zero of the gauge during the entire month, and at Cameron it was at zero during the greater part of the month. At Wilkesbarre, on the north branch, the gauge registered 1 foot below zero until the 28th, when it rose to zero, and on the 31st had risen to 5.0 feet above. At Harrisburg the river rose 2.7 feet from the 27th to 30th, the highest point touched being 4.5 feet on the 30th.

Rivers of South Atlantic States. (Reported by E. A. Evans, Richmond, Va.; C. F. von Herrmann, Raleigh, N. C.; L. N. Jesunofsky, Charleston, S. C.; D. Fisher, Augusta, Ga.; and J. B. Marbury, Atlanta, Ga.)—There were no changes of importance occurring in the James River at any time during the month. A uniform low stage of water was maintained, the range between the highest and lowest readings being only 0.9 foot. Rains were frequent over the watershed during the second decade of the month, but they were light and caused no rise worthy of mention. The water was clear from the 1st to 10th, and cloudy the remainder of the month.

Low river stages continued in all the rivers of North Carolina during the first half of July, notwithstanding the fact that the number of rainy days was large and the rainfall considerable. The rainfall was smallest over the basin of the Roanoke and tributaries, and only one 5-foot rise occurred in that stream (3d to 4th) to a stage of less than 10 feet on the gauge at Weldon. Over the Cape Fear Basin heavy rains caused a minor rise on the 14th, and a 20-foot rise in two days (20th to 22d) in the Cape Fear River at Fayetteville. Steamboat navigation on the lower courses of the streams was resumed the latter portion of the month; on the Cape Fear navigation has not been interrupted, steamers continuing to ply between Wilmington and Fayetteville the entire month.

Low but navigable water was maintained on all streams in South Carolina, except at Cheraw from the 1st to the 10th. The heavy rain between the 8th and 21st produced steady rises in the Waccamaw, Edisto, Lynch, Lumber, Black, the lower Pedee, and Santee rivers between the 11th and 31st. Navigation was interrupted at Cheraw from the 1st to the 8th and on the 30th and 31st. Excessive precipitation on the headwaters of the Wateree and Pedee in North Carolina during the 19th and 20th caused moderate freshets at Camden on the 21st and 22d and at Cheraw on the 22d and 23d.

The Savannah River remained at a moderately low stage, yet high enough for navigation, until the 20th, when, from the effects of hard showers in the upper basin, a rise of a little over 7 feet occurred at Augusta. The river, though shallow for the entire month, was less clear than is usual for low summer stages, a fact which river men are unable to explain. Navigation was continued during the month without interruption and the river boats were favored with fairly good cargoes. There were no decided changes in the other Georgia rivers, and they have averaged low during the entire month. The rains which have occurred have caused but slight and temporary rises.

Mobile River and branches. (Reported by F. P. Chaffee, Montgomery, Ala., and W. M. Dudley, Mobile, Ala.)—The water in the Alabama River and its tributaries continued low during the first decade, after which well-distributed rains over the watershed gave navigable stages. River traffic was resumed above Selma after the 12th, but all the streams were steadily falling again toward the close of the month.

The Tombigbee and branches were low at the opening of the month, being below the gauge zero at all stations, and continued falling until the 7th. There were heavy rains on the headwaters of the river during the early and middle parts of the month, which caused short rises. The greatest rise occurred on the 19th, when, at Tuscaloosa, the Tombigbee rose 9 feet in twenty-four hours. The rise continued to the 21st, when the river was over 15 feet above the zero of the gauge. The rise made the river navigable for coal barges which left Mobile and reached Tuscaloosa in safety. All rivers fell from the 22d to the end of the month, at which time navigation was somewhat threatened.

Ohio River and branches. (Reported by F. Ridgway, Pittsburg, Pa.; H. L. Ball, Parkersburg, W. Va.; S. S. Bassler, Cincinnati, Ohio; F. Burke, Louisville, Ky.; P. H. Smyth, Cairo, Ill.; L. M. Pindell, Chattanooga, Tenn.; and H. C. Bate, Nashville, Tenn.)—During the first three weeks of the month the upper Ohio continued at such a low stage that navigation was practically suspended. Rainfalls from the 17th to the 21st, however, caused an important rise which opened the river for packet navigation at Pittsburg during the remainder of the month. The wickets at Davis Island Dam were lowered on the 20th, and during the next four days 2,205,000 bushels of coal passed through the lock at that point bound for southern ports. During the last few days of the month the river fell steadily, and the month closed with barely sufficient water for packet navigation.

The rainfall over West Virginia was light during the first half of July and after the 3d all the rivers showed falling stages. Moderately heavy rains along the Great and Little Kanawhas on the 1st and 2d caused a slight rise, but this passed quickly. From the 11th to the close of the month rains were frequent and moderately heavy. The rivers rose slowly and most of them held good stages for navigation. At Parkersburg the largest packets were tied up for three weeks, but were released about the 20th and resumed business.

At Cincinnati river business was fairly active throughout the month. A small rise from the 3d to the 6th helped navigation materially during the period of low water. There was a good boating stage of water at Louisville during the entire month. The average depth was 6.4 feet, somewhat greater than the average for July.

At Cairo a good stage of water was maintained throughout the month. Combined rises out of the Cumberland, Tennessee, Ohio, and Mississippi gave Cairo a moderate rise, starting in on the 26th and continuing to the end of the month. River business during the month has been generally quiet, but this is not unusual at this season of the year.

For the sixth time since 1879 the Tennessee River has been navigable during the entire month of July. Heavy rains over the headwaters from the 2d to the 25th produced one of the best boating and logging tides for the month ever known. Reports on the 27th stated that the river had risen 16 feet at Charleston and was still rising; that the bottom lands were covered and the Hammond bottom, just across the river from Charleston, was covered up to the top of the tall corn. On July 28 reports from Clinton stated that the Clinch River was out of its banks, and that the Emory, French Broad, and Holston were at high water. The lumbermen of Chattanooga received news from the headwaters on the 27th that the Upper Clinch and Tennessee rivers had risen and a big log fleet had started down.

The month was unusually wet in the Cumberland Basin, and the river was held at a favorable stage for navigation in its upper divisions during the last half of the month, and in its lower divisions the entire month, and the month closed with the river open from Celina to its mouth.

Mississippi River and minor branches. (Reported by P. F. Lyons, St. Paul, Minn.; M. J. Wright, Jr., La Crosse, Wis.; G. E. Hunt, Davenport, Iowa; F. Z. Gosewisch, Keokuk, Iowa; H. C. Frankenfield, St. Louis, Mo.; P. H. Smyth, Cairo, Ill; S. C. Emery, Memphis, Tenn.; R. J. Hyatt, Vicksburg, Miss.; R. E. Kerkam, New Orleans, La.; and C. Davis, Shreveport, La.)—The month of July, 1897, was an eventful one inasmuch as there was not only a sufficiency of water in the Mississippi River to meet all the wants of navigation, but at the beginning of the second decade the water came within a few tenths of a foot of the danger line, or 14 feet on the gauge, at St. Paul; there was a daily average reading of 10.3 feet; the largest previous July average, determined from the last twenty-five years' record, was 7.6 feet, in 1874. The heavy and excessive rains over northern Minnesota during the early part of the month caused a continuous rise in the river ranging from 0.1 foot to 2.1 feet a day from the 1st to the 11th, when the maximum of 13.6 feet was registered; afterwards there was a gradual and almost steady fall to the end of the month, when the reading was 9.0 feet. Reports indicate that the Mississippi near its source was higher at the opening of this month than it was at any time last spring, and some loss to both crops and houses was reported from Aitkin County in consequence of overflow.

The average stage of water in the Mississippi River at La Crosse was higher than during any former year since the beginning of observations, and has materially interrupted the work of the Government engineers in this district. The gauge readings ranged from 7.3 to 10.5 feet. The water has been at an excellent stage for navigation. On several occasions the water has reached a maximum stage in July greater than was attained during the present month, but high water did not continue during the entire month as it did this year.

An excellent stage for navigation was maintained at Davenport during the entire month. The close of the month found the river somewhat higher than at the beginning. The rainfall was above normal from the head of the river to Reeds Landing. At La Crosse less than

half the normal precipitation occurred. At North McGregor and Dubuque it was slightly above, while from Le Claire to Muscatine it was somewhat below the normal. The river at Keokuk has continued at an unusually high stage for the month of July, with small range. The stage has been ample for navigation of the Des Moines Rapids for the largest steamboats and heaviest lumber or log rafts.

Exceptionally good boating stages were maintained throughout the month at St. Louis, but at the same time the tendency was downward, and at the end of the month there was from 6 to 8 feet less water than at the beginning. The lower cross levee at the head of the Indian Grave levee district broke on the 25th a short distance above Quincy, Ill. The break was occasioned by the overflow waters of Bear Creek after the heavy rains of the 24th and 25th. The break was about 1,000 feet in length, and the bottoms were flooded for a distance of 6 miles, causing considerable damage to the fields of ripening corn and other crops. From St. Louis to Cairo the river was falling during most of the month, but occasional rises kept the water at a good stage.

During the first four days of the month the river rose below Cairo from six to eight tenths of a foot daily, reaching the maximum stage of 18.3 feet, at Memphis, on the 4th. From that time the water fell steadily, reaching the minimum, 11.3 feet, on the 24th. During the last three days of the month the river rose 2.5 feet, bringing the reading up to 14 feet, which is considered a good stage for the end of July, and is 11 feet higher than was recorded on the same date in 1896. The month, as a whole, was exceptionally favorable for river navigation on the Mississippi and all navigable tributaries in this section, the water being generally higher than the average for July.

The rivers between Memphis and Vicksburg showed slight fluctuations during the month. Fair boatable water was maintained during the greater portion of the month and river traffic was good. The stage of water at Vicksburg was sufficient for small boats to land at the city front a portion of the month. Crops in the section recently overflowed have made remarkable growth and progress and with a late frost a good crop of cotton will be made on those lands. A moderately low stage of water continued in the Mississippi below Vicksburg during the entire month, the first ten days showing a rise of about 6 feet at Vicksburg, decreasing to less than a foot at New Orleans. After this there was a general decline to the close of the month.

During the first half of July, little or no precipitation fell in the watershed of the Red River, and decreasing stages were general. On several days during the latter half of the month liberal rains occurred and sharp rises characterized the stream, especially the upper portion. At Shreveport the stages were sufficient for navigation, the month opening with 9.3 feet on the gauge and closing with 6.0 feet.

Missouri River and branches. (Reported by L. A. Welsh, Omaha, Nebr., and P. Connor, Kansas City, Mo.)—There has been nothing unusual or noteworthy in the condition of the Missouri River during the month. The stage of water was somewhat variable during the earlier part of the month, but after that period the stage decreased slowly and steadily. The entire range of river stage during the month was only about 2.5 feet. The east bank of the Missouri River, directly opposite Plattsmouth, Nebr., is reported as cutting badly.

Arkansas River. (Reported by J. J. O'Donnell, Fort Smith, Ark., and F. H. Clarke, Little Rock, Ark.)—The upper Arkansas River continued low and was falling steadily to the 10th. On the morning of the 11th it had risen 2.0 feet to a stage of 5.0 feet, afterward falling slowly but steadily until the close of the month. Except between the 11th and 14th the river was below a navigable stage.

The lower Arkansas River maintained a uniform condition during the month. The average stage from Fort Smith to Little Rock was about 3.0 feet lower than for the corresponding month last year. Navigation was pursued uninterruptedly from Little Rock to the mouth, but the river was too low above Dardanelle to make navigation profitable on many days.

Heights of rivers above zeros of gauges, July, 1897.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
St. Paul, Minn.	1,957	14	13.6	11	6.5	1	10.3	7.1
Reeds Landing, Minn.	1,887	12	9.2	12-14	5.4	1	7.2	3.8
La Crosse, Wis.	1,822	10	10.5	17,18	7.3	2	8.7	3.2
North McGregor, Iowa	1,762	18	10.6	21,22	8.4	10	9.2	2.2
Dubuque, Iowa	1,702	15	10.2	24-27	8.3	5-7	9.1	1.9
Leclaire, Iowa	1,612	10	6.4	24-28	5.3	7-10	5.7	1.1
Davenport, Iowa	1,596	15	7.9	27,28	6.6	8-10,17	7.1	1.3
Keokuk, Iowa	1,466	14	7.8	26	6.0	13	6.8	1.8
Hannibal, Mo	1,405	17	9.8	26	7.2	13-15	8.0	2.6
Grafton, Ill	1,307	23	13.2	27,28	8.5	23	10.4	4.7
St. Louis, Mo.†	1,264	30	22.7	4	12.8	23	17.6	9.9
Chester, Ill.	1,189	30	16.8	5	9.4	25	12.8	7.4
Cairo, Ill	1,073	40	24.9	2	16.8	20,21	20.6	8.1
Memphis, Tenn	843	33	18.3	4,5	11.3	24	14.7	7.0
Helena, Ark	767	44	24.8	6-8	16.5	24-29	20.6	8.3
Arkansas City, Ark	635	42	24.8	9,10	16.5	27-30	20.9	8.3
Greenville, Miss	595	40	20.3	9,10	13.4	29,30	17.1	6.9

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Mississippi River—Cont'd	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Vicksburg, Miss	474	41	24.0	12	15.2	31	20.3	8.8
New Orleans, La	108	16	7.1	10,11	4.5	29-31	6.2	2.6
Arkansas River.								
Fort Smith, Ark.	345	22	5.0	11	2.9	3	3.6	2.1
Dardanelle, Ark.	250	21	3.4	13	1.6	10	2.2	1.8
Little Rock, Ark.	170	23	5.8	24	4.0	11,12	4.8	1.8
White River.								
Newport, Ark	150	21	3.2	3	1.8	18-20	2.4	1.4
Illinois River.								
Peoria, Ill.	135	14	9.1	1	4.9	30,31	6.5	4.2
Missouri River.								
Bismarck, N. Dak.	1,201	14	7.3	1,4	5.2	30,31	6.1	2.1
Pierre, S. Dak.	1,006	14	7.4	2,3	4.8	30,31	6.1	2.6
Sioux City, Iowa	676	19	11.5	7	8.4	31	10.1	3.1
Omaha, Nebr.	561	18	11.6	1	9.2	31	10.2	2.4
St. Joseph, Mo.	373	10	7.7	1	4.4	31	5.9	3.3
Kansas City, Mo.	280	21	18.0	2	9.8	28	13.7	8.2
Boonville, Mo.	191	20	16.5	3	9.2	31	12.3	7.3
Hermann, Mo.	95	21	13.5	3	4.9	30,31	8.5	8.6
Ohio River.								
Pittsburg, Pa	966	22	8.1	24	4.3	6	5.9	3.8
Davis Island Dam, Pa.	960	25	9.4	24	2.6	2,3	4.9	6.8
Wheeling, W. Va.	875	36	13.8	24	2.8	3-5	5.9	11.0
Parkersburg, W. Va.	785	35	13.5	25,27	5.0	11	8.2	8.5
Point Pleasant, W. Va.	703	36	17.5	26	3.8	12	8.7	13.7
Catlettsburg, Ky	651	50	23.2	26	5.2	1	11.4	18.0
Portsmouth, Ohio	612	50	23.0	26,27	7.0	1	12.4	16.0
Cincinnati, Ohio	499	45	24.8	28	9.1	3	13.9	15.7
Louisville, Ky.	367	24	9.3	28,29	4.9	4	6.4	4.4
Evansville, Ind	184	30	17.4	31	6.5	7	9.4	10.9
Paducah, Ky.	47	40	14.7	31	6.3	19,20	9.3	8.4
Alleghany River.								
Warren, Pa	177	7	1.1	7,25	0.0	1-6	0.5	1.1
Oil City, Pa	123	13	2.7	20,25	0.4	7	1.5	2.3
Parkers Landing, Pa.	73	20	4.5	23	0.6	8	2.0	3.9
Freeport, Pa.	26	20	8.0	23	1.2	8	3.6	6.8
Conemaugh River.								
Johnstown, Pa.	64	7	2.8	22,28	0.8	5	1.6	2.0
Red Bank Creek.								
Brookville, Pa.	35	8	2.2	21	— 0.9	1-11	0.2	3.1
Beaver River.								
Ellwood Junction, Pa.	10	14	5.8	23	— 0.2	4,5	1.4	6.0
Cumberland River.								
Burnside, Ky	434	50	8.7	17	1.3	5	3.9	7.4
Carthage, Tenn.	267	30	12.6	26	2.1	3	5.6	10.5
Nashville, Tenn	175	40	15.6	27	3.4	4,7	7.6	12.2
Great Kanawha River.								
Charleston, W. Va.	61	30	13.4	3	4.8	11	6.3	8.6
New River.								
Hinton, W. Va.	95	14	4.0	24	1.5	18	2.3	2.5
Licking River.								
Falmouth, Ky.	30	25	5.0	27	1.5	17	2.4	3.5
Miami River.								
Dayton, Ohio	69	18	5.0	22	1.2	14,16	1.9	3.8
Monongahela River.								
Fairmont, W. Va	119	25	6.1	23	0.4	1,2	2.0	5.7
Greensboro, Pa.	81	18	10.3	23	7.1	1,2	8.3	3.2
Lock No. 4, Pa.	40	28	12.0	24	6.4	1,2	8.6	5.6
Cheat River.								
Rowlesburg, W. Va.	36	14	5.0	27	2.0	1,2,12	3.2	3.0
Youghiogheny River.								
Confluence, Pa.	59	10	2.4	23	0.4	6,7	1.0	2.0
West Newton, Pa.	15	23	1.5	21	0.0	15-18	0.4	1.5
Muskingum River.								
Zanesville, Ohio	70	20	9.2	24	5.5	6,10	6.8	3.7
Tennessee River.								
Knoxville, Tenn.	614	29	3.0	12,13	2.2	6,10,29	2.5	0.8
Kingston, Tenn	534	25	7.2	26	1.3	15,16	2.6	5.9
Chattanooga, Tenn.	430	33	13.3	27	3.4	4,5	5.5	9.9
Bridgeport, Ala	390	24	9.9	27	1.7	5	3.7	8.2
Florence, Ala.	220	16	7.7	29	1.7	7	3.3	6.0
Johnsonville, Tenn.	94	21	9.5	31	3.3	9-12	4.8	6.2
Clinch River.								
Speers Ferry, Va.	156	20	7.4	22	0.2	5,6,19	1.2	7.2
Clinton, Tenn	46	25	12.5	23	3.6	4	5.6	8.9
Wabash River.								
Mount Carmel, Ill.	50	15	4.3	1	2.8	22-25	3.2	1.5
Red River.								
Arthur City, Tex.	688	27	13.4	23	3.6	8	7.0	9.8
Fulton, Ark	565	28	11.4	27	3.9	20-22	5.9	7.5
Shreveport, La.	449	29	9.3	1	2.7	25-27	4.9	6.6
Alexandria, La	139	33	9.3	1	0.5	31	3.5	8.8
Atchafalaya Bayou.								
Melville, La.	100	31	22.5	1	14.8	31	20.1	7.7
Ouachita River.								
Camden, Ark.	340	39	5.3	23	3.2	15-18	3.9	2.1
Monroe, La	100	40	7.5	1	1.3	17,18	2.4	6.2
Yazoo River.								
Yazoo City, Miss.	80	25	2.5	25,26	— 0.1	7	0.9	2.6
Chattahoochee River.								
Columbus, Ga.	140	20	11.0	22	0.6	19	3.2	10.4
Flint River.								
Albany, Ga.	80	20	5.7	9	1.0	4,5	3.1	4.7
Cape Fear River.								
Fayetteville, N. C.	100	38	25.3	22	1.9	6	6.5	23.4
Columbia River.								
Umatilla, Oreg	270	16	16.9	5,6	10.6	31	14.3	6.3
The Dalles, Oreg.	166	40	27.5	6	16.7	31	23.2	10.8
Willamette River.								
Albany, Oreg	99	20	3.4	1	1.3	31	2.2	2.1
Portland, Oreg	10	15	14.9	1,7	8.4	31	12.4	6.5
Edisto River.								
Edisto, S. C	75	6	5.1	29	1.7	9,10	3.0	3.4

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger-line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
James River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Lynchburg, Va.	257	18	1.9	23	0.1	17-19	0.6	1.8
Richmond, Va.	110	12	0.7	24	— 0.2	2, 9, 10, 12	0.2	0.9
Alabama River.								
Montgomery, Ala.	265	35	8.4	24	0.5	2	2.8	7.9
Selma, Ala.	212	35	9.8	25	0.5	3	3.3	9.3
Coosa River.								
Gadsden, Ala	144	18	10.1	22	0.0	1	2.6	10.1
Tombigbee River.								
Columbus, Miss.	285	33	— 0.2	17	— 3.0	31	—2.3	2.8
Demopolis, Ala.	155	35	8.2	23	— 1.5	2-6	1.2	9.7
Black Warrior River.								
Tuscaloosa, Ala.	90	38	14.5	21	— 0.2	2-4	3.4	14.7
Pedee River.								
Cheraw, S. C.	145	27	20.4	23	2.0	31	5.4	18.4
Black River.								
Kingstree, S. C.	60	12	3.7	30, 31	1.3	11-13	2.5	2.4
Lumber River.								
Fair Bluff, N. C.	10	6	5.1	31	— 0.4	9	1.7	5.5
Lynch Creek.								
Effingham, S. C.	35	12	12.1	29	2.5	7, 8	5.2	9.6
Potomac River.								
Harpers Ferry, W. Va.	170	16	2.0	28	0.1	19	1.1	1.9
Roanoke River.								
Clarksville, Va.	155	12	.....	.....	... .	.....	.....	.....

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
Sacramento River.	*Miles.*	*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Red Bluff, Cal.	241	23	1.0	1-5	0.1	23-31	0.5	0.9
Sacramento, Cal.	70	25	13.8	1	10.0	31	11.6	3.8
Santee River.								
St. Stephens, S. C.	50	12	7.3	28-31	2.6	7	5.3	4.7
Congaree River.								
Columbia, S. C.	37	15	3.5	21, 22	1.5	1-13, 15-19, 24-31	1.7	2.0
Wateree River.								
Camden, S. C.	45	24	22.5	22	4.0	2-4, 8	7.4	18.5
Savannah River.								
Augusta, Ga.	130	32	16.6	20	5.7	17	8.5	10.9
Susquehanna River.								
Wilkesbarre, Pa.	178	14	5.0	31	— 1.0	1-27	—0.5	6.0
Harrisburg, Pa.	70	17	4.5	30	1.0	13, 15, 16	1.6	3.5
Juniata River.								
Huntingdon, Pa.	80	24	4.0	19, 28, 29	2.8	10-18	3.1	1.2
W. Br. of Susquehanna.								
Williamsport, Pa.	35	20	4.8	30	0.7	6-9	1.5	4.1
Waccamaw River.								
Conway, S. C.	40	7	2.2	7, 30	0.6	26	1.6	1.6

*Distance to the Gulf of Mexico. † Record for 28 days

SPECIAL CONTRIBUTIONS.

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THE OBSERVATION OF HALO PHENOMENA.[1]

(Translated from a separate print from the annual volume of the Natural History Association of Wurtemberg. Communicated by Rev. K. SCHIPPS; dated Feb., 1897.)

The light from the sun, moon, and brighter stars, by means of refraction through or reflection on ice crystals—when the latter occur in great numbers, in definite positions, over a considerable region—manifests itself in figures of manifold forms, known as halo phenomena. These are very seldom observed in crystals of ice that lie upon the surface of the earth; more frequently, but still rarely, in those crystals that float in the atmosphere in the immediate neighborhood of the observer so that, for instance, they rarely develop between the observer and any distant object. As a rule, and, indeed, by no means so rarely as is ordinarily thought, halos occur in the clouds or haze of ice crystals at different altitudes in the atmosphere, but above the observer's head. The most frequent form of halo is a circle around the star whose light produces it, having a radius of about 23°; that is to say, the line from the eye to the star makes an angle of about 22° to 23° with the line from the eye to the circle. The circle shows the colors of the rainbow, beginning with red on the inside of the circle (in contrast to the rainbow, where the red is on the

[1] The Chief of the Weather Bureau has just received from Rev. K. Schipps, of Baustetten, near Laupheim, Wurtemberg, Germany, a letter requesting the cooperation of those interested in the study of halos. A committee for this purpose has been formed in Germany, on behalf of which Mr. Schipps has issued a circular, which we translate herewith, and which will be found instructive as a guide to both observers and students.